Common Property's Role in Water Resource Management

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It is a great honor for me to be invited to speak to this international gathering, and to do so in such esteemed company. I am grateful for the invitation.

Here is an outline of my remarks. Since I was invited to speak about common-property arrangements in the management of water resources, I shall begin with a description of common-property arrangements. I will then turn to the relationship between the common-property and regulatory-agency approaches to water resource management, addressing both its empirical manifestations and some theoretical bases for understanding them. Then I will consider the relationship between common-property and private-property or market arrangements, again analyzing that relationship from empirical and theoretical perspectives. When I use examples or illustrations in this brief presentation, they will have to do with groundwater basins in the United States since those are the empirical cases with which I am familiar. And throughout my remarks, I will be applying the analytical approach of institutional rational-choice analysis, and restating the work of many scholars who have worked in the field of common-property resources.

As those scholars have taken great care to point out, common-property arrangements in the management of natural resources assume a nearly endless variety of forms, but there are three forms of the organization of resource use that are *not* common-property forms. First and most important, common property does not mean the open-access conditions

associated with the "tragedy of the commons." Part of the definition of a common-property resource is that property rules establish criteria for identifying who may have access to the resource and its yield. Thus, an identifying characteristic of property rights—the ability to exclude—is part of this conception of common property. Where limitations on access do not suffice to maintain the resource in the conditions desired by the users, common-property arrangements typically establish some other limitations on use. Thus, the common-property resource is not merely a "common pool" that anyone may exploit to any degree as long as the marginal benefits to him or her exceed the marginal costs.

The two other forms of organization of resource use that do not fall within the set of common-property arrangements are complete external control and complete privatization. Complete external control refers to the notion of a central agent or agency, directed by someone other than the resource users, which regulates all relevant aspects of their use of the resource. This is not a common-property regime since the users neither individually nor collectively possess any property interest in the resource. Complete privatization refers to the notion of each individual user possessing full control over all aspects of the resource desired by him or her, so that his or her decisions about resource use are entirely private and the benefits and costs internalized to the degree possible. Such a situation is also not a common-property regime; these users possess property but their decisions and behaviors are not made or experienced in common.

Even after we distinguish common-property arrangements from these three other forms, a vast array of resource use and management systems remains within the common-property category. In a common-property water resource system, users of a particular resource-stream, canal, aquifer, lake, etc.—typically exclude others from outside the common user group, but no individual user within the group can exclude another within the group from having access to the common-property resource.

The common-property users may have joint but regulated access to the water resource

through a system of shares in the flow or through allocations of time or space. Their access often is coupled to obligations to supply contributions of labor or capital or both to the maintenance or improvement of the resource. Their access often is accompanied by restraints on activities that would degrade the quality of the resource or interfere with the access rights of other authorized users. In these ways, many common-property systems in water resources management exhibit features similar to a regulatory approach to management—common rules limit use, require contributions to collective goods, and restrain undesirable behaviors.

The common-property users often also have facilities of their own—that is, one or more wells, ditches, gates, or turnouts by which they capture and bring to use their share of the common supply. Where this is the case, the responsibility for the maintenance of those facilities ordinarily rests with the individual or household that controls them. Individual users may exclude other users within the group from access to or interference with these sorts of individually-controlled facilities—in other words, you and I have may co-equal rights to the use of the aquifer but usually that does not mean you can start pumping my well.

Furthermore, the common-property rules may allow users to exchange within the group their shares or time slots. Water users who wish to exit the system or cease production can almost always return them to the group, but in many instances also have the option of transferring them for some consideration to another user, and in some instances this may even provide an occasion for a new user to enter the group and gain access to the resource. When the water resource includes a storage component (as with most aquifers, or in an irrigation system that consists of tanks as well as canals and ditches), users may also be able to "carry over" some or all of an unused allocation from one period to another. In these ways, many common-property systems in water resources management exhibit features similar to a market approach to management—users possess property interests in their own facilities and can transfer resource shares among themselves or across time.

In their book, Water Markets. Terry Anderson and Pamela Snyder describe several common-property arrangements devised to accomplish water development objectives prior to or during the 19th century in what is now the western United States—the communal flood control and water conservation facilities of the Zuni and Hopi Indians, the jointly-constructed and -maintained water distribution systems of the Hohokham Indians, the Mormon town-site and irrigation arrangements that included the issuance of shares and the contribution of labor for maintenance, and the nonprofit mutual water companies that gathered financial capital for the construction of facilities to deliver water supplies in which shareholders had rights in proportion to their shares. As Anderson and Snyder describe, these types of organizations did as much or more to bring western lands under cultivation in the United States than the larger-scale federal water projects that are more commonly associated in popular culture with the development of the American West.

By now most of you will have discerned the principal theme of my presentation this morning: while common-property arrangements are *distinguishable* from completely governmental/regulatory and completely private/market arrangements, they are not inherently incompatible with either, and often coexist and overlap with both. Many common-property arrangements in water resources—at least in the United States and probably elsewhere—contain elements of market exchange, of private ownership, and of collective regulation. Because common-property arrangements have ordinarily been crafted and revised by the users themselves, it is not surprising that they have a pragmatic, non-ideological, and often hybrid institutional character.

That is not to say that common property arrangements are an unimportant category that is just a melange of what is left over after the agency and market categories have been filled. As Elinor Ostrom and others have documented, common-property resource management systems exist in all parts of the world and for all types of natural resources. And as I have tried to point out, there are characteristics of common-property arrangements that define the category—elements of commonality combined with the elements of property.

In that connection, I would like to add two other distinguishing features of common-property systems. First, nearly all of them—at least, nearly all of the successful and surviving ones—were and are organized and operated by the resource users themselves. Users either organized around an existing scale such as the village or clan, or defined their membership and rules ad hoc around the shared resource itself, as with user associations or cooperatives and special-purpose bodies such as water districts. Second, successful and surviving common-property arrangements operate under rules that not only are devised and adopted by resource users, but are subject to review and change by the users. Successful and lasting common-property arrangements typically demonstrate adaptability as the users reconstitute, redirect, and revise them.

Of course, it is one thing to build the empirical case for the recognition of common-property arrangements—to demonstrate through the accumulation of serious research efforts that the number of instances of common-property resource regimes in practice in the world of water is large and likely surpasses those of either the central-agency or the private-market variety. It is another matter to develop and apply the analytical or theoretical elements that locate the study of these arrangements within the more general domain of the social sciences. For the remainder of my time, I would like to identify a few analytic elements from the field of applied economics that may help explain both the frequency with which common-property arrangements have been employed by water users and the overlap these arrangements often exhibit with central-agency and private-market approaches.

In the management of aquifers in the American West, common-property arrangements developed and implemented by the users frequently coexist and operate alongside regulations imposed by external agencies (i.e., agencies of the state or national government). Does this fact represent anything more than the accumulation of happenstance, a random but path-dependent evolutionary process? And if it does, what elements of economic analysis could help us to understand it?

Common-property arrangements are more typical than external-agency regulation in western groundwater management with respect to matters such as the allocation of storage rights, the assignment and collection of the costs of maintenance or replenishment of the aquifer, and negotiating with overlying local governments over land-use and economic development decisions that may affect aquifer recharge zones or future water demands. External-agency regulation is more typical than user-based common-property arrangements with respect to such matters as the establishment and enforcement of well construction standards, the development and monitoring of water quality standards, and the regulation of effluent discharges and reuse.

Although we cannot rule out other explanations, I believe that a rational-choice analysis applying the concepts of scale economies, the free-rider or collective-action problem, and time-and-place specificity can provide a logical and useful explanation of why this apparent "division of labor" has arisen in western groundwater management.

The Hayekian notion of time-and-place specificity is useful for understanding why external-agency regulation of groundwater storage, recharge programs, and the interaction of local land-use and water-resource decisions is uncommon. The aquifers of the American West, like aquifers throughout the world, display an enormous variety of sizes, shapes, composition, location within watersheds, and other such characteristics that combine to determine their vulnerability or resilience in the face of overdrafting, their capacity for and rate of replenishment, the impacts one pumper's production has on other pumpers, the location and permeability of recharge zones, and so on. Like snowflakes, aquifers all belong to one category but each is unique.

Even though advocates of the regulatory approach may find it distressing that user-based arrangements are often slow in coming and imperfect in design and execution, external agency management of water storage and recharge issues would likely exhibit either of two disadvantages: on the one hand, a uniform set of regulations that did not take the large

differences among aquifers into account would be grossly inefficient, but on the other hand, the information costs an agency would face in tailoring regulations for each aquifer within its jurisdiction would be formidable if not insurmountable. Aquifer storage and recharge rules, as well as the assignment of costs for the implementation of those rules, have more often been developed and decided by the pumpers themselves through the organizational mechanism of a water users' association, a mutual water company or other cooperative, the formation of a special water district, or the undertaking of an adjudication and settlement. Given the time-and-place specificity demands of aquifer management, this represents an efficiency gain over central agency control.

Scale economies and the free-rider/collective-action problem help to account for the greater reliance on regulatory approaches involving state and national agencies. The research on health effects from water degradation is so expensive to conduct that there are likely to be efficiency gains from organizing it centrally rather than duplicating it in each basin or watershed. In addition, the findings concerning water quality and human health should apply generally throughout a jurisdiction—in other words, there is little reason to assume that the impact of nitrates, for example, on human health is different in northern California than in southern California—so the time-and-place specificity characteristics are diminished while the scale economies are arguably greater. Furthermore, even if the costs were not prohibitive, aquifer-specific user organizations would be reluctant to invest intensively in research on water quality since the benefits of that research would extend well beyond that basin; thus, each user organization would face some temptation to wait and take a free ride on the research generated by another entity.

It is, therefore, not only empirically evident that common-property arrangements exist alongside external agency regulations within western U.S. groundwater management systems, but there is some logic for the evolution of these systems. Rather than being perceived as contradictory, common-property and regulatory approaches can be complementary when organized in ways that recognize the demands of time-and-place-

specific information, scale economies, and the collective action problem.

At the same time, common-property arrangements also exist alongside private-property and market arrangements in western groundwater management. Can this juxtaposition also be analyzed beneficially using concepts from applied economics? Again acknowledging that other explanations are possible, I believe the concepts of risk and uncertainty, transaction costs, and again the free-rider/collective-action problem help to make the choice to combine common-property and private-property arrangements more nearly understandable.

Where private-property and market institutions exist in western water, they usually are limited to withdrawal rights defined quantitatively—cubic feet per second, acre-feet per year, and so on. Whether through the prior appropriation system or by permits issued by the state or division engineer or by a court order giving effect to a stipulated judgment ending an adjudication, many water users in the American West have defined rights to a share of the flow or yield of a stream or aquifer system. On the other hand, as Professor Anderson and his colleagues have repeatedly pointed out, rights to specific amounts of the water in underground storage, or of the annual basin replenishment, and the maintenance of water levels and instream flows are typically not privatized and transferable in a market. To the extent that basin storage and recharge operations exist, they are more commonly undertaken as collective efforts by and on behalf of organizations of water users. How might we account for this choice of a mix of institutional arrangements within a rational-choice framework?

The repeated willingness of water users, at least as their willingness is expressed in their institutional choices, to maintain one set of institutional arrangements for the water "stock" and another for the "flow," one set of arrangements for in-channel uses and another for out-of-channel uses, and one set of rules for the allocation of the base flow of a watercourse and another set for the capture and use of surplus flows may be vexing to those who have normative designs to prescribe, but that does not mean that water users have lost their

minds or chosen this mix of institutional arrangements irrationally.

Traditional economic models of aquifer systems often abstract some of the physical characteristics that affect water users' decisions about the management of the water levels, storage capacity, and recharge quantities. Most economic models that I have seen, for example, assume that all users are similarly situated with respect to the aquifer, so increases in production that lower water levels do so evenly across the producers and show up merely as increases in their pumping costs. In these models, aquifers are mined until a balance is reached at the point where declining marginal benefits and rising marginal costs intersect. In these models, aquifers are flat-bottomed tubs with vertical sides. All modeling involves simplification, so one may not object to that, but the question is still begged, why do so few groundwater management arrangements observed in the American West just let "nature" (so to speak) take its course?

Real aquifers are not flat-bottomed tubs with vertical sides. Their contours are usually not understood completely by the pumpers even after long experience, so any pumper's experiments with water levels is conducted with some risk to others. And some experiments have irrevocable consequences—the soils of dewatered aquifers do compact, creating a loss of storage capacity that will to greater or lesser degree thwart later efforts to replenish the aquifer, and the overlying lands of dewatered aquifers do subside. One can argue that these are compensable losses and that therefore the risks should be allowed, but it is equally valid to argue that where such risks are (albeit imprecisely) foreseeable it is prudent to avoid them. Who should choose? In common-property arrangements, the water users do.

The subterranean features of aquifers also inevitably leave some pumpers more exposed than others to variations in basin conditions. In every real aquifer, some pumpers overlie shallower portions while others overlie deeper ones, and thus the distribution of benefits and harms their actions impose on one another is far from uniform. Even when all other

things (such as the pumpers' financial capacity to sink wells and set pumps) are equal, some will nevertheless go dry before others. Furthermore, while we ordinarily think of variations in basin conditions in terms of the undesirable *lowering* of water levels, underground water levels can also rise too near the ground surface, and the exposure from these variations too is distributed unevenly across pumpers. In one case I am familiar with, underground water levels in the upper portion of the aquifer saturate the root zone and harm crops when allowed to rise too high, and in another, underground water levels in the downgradient portion of that aquifer infiltrate people's basements and mingle the groundwater with undesirable fertilizers found in the near-subsurface soils when allowed to rise too high.

While on the one hand, the uniqueness of aquifers works against central-agency management of water in storage, the uncertainty about the aquifer's subterranean features combines with the uneven distribution of pumpers' situations to encourage water users in many real-world cases to try to find ways to maintain water levels within a range that allows all established users to continue to receive benefits from the aquifer, even if this means that some of them forego opportunities to gain greater advantage from fluctuating water levels. This minimax strategy may not extract optimum economic value from an aquifer, but users may prefer avoiding maximum losses, and so again we are brought to the question of who should choose.

A strong argument can be and has been made that private-property and market arrangements can address these risks and exposures quite well, that any pumper can assert his or her rights against any other pumper who causes interference with or harm to his or her water. Water users in real aquifers may, however, choose other means of assuring their rights based quite rationally on considerations of transaction costs. Both the characteristics of aquifers and the number of water producers may boost the transaction costs of the find-'em-and-sue-'em approach beyond the reasonable reach of the individual firm or household.

Consider the individual pumper's perspective. A certain amount of common sense would lead a pumper to conduct a limited search for the one who is interfering with his or her well by starting with neighboring producers. Many times that sensible strategy will yield results quickly and economically. But allow me to use an illustration—hardly an exotic one—of an aquifer in which that reasonable search strategy would be fruitless. This aquifer, like many, is sloped in such a way that downgradient producers enjoy artesian flow while upper producers have to construct wells and set pumps. Increased production by one or more upper producers certainly imposes incremental costs on other upper producers in the form of lengthened pumping lifts, but its most serious and costly harm may be visited upon those water users several kilometers away whose artesian wells cease flowing and who must then undertake the costly transformation from an artesian to a pumping well in order to continue to have water from the aquifer. The producers who suffer those losses will search in vain among their neighbors for the perpetrators of their suffering, and by the time the distant culpable party or parties are identified and compensation made, much additional (and on the whole, inefficient) expenditure of resources will have occurred. The question here is not whether the private-property-plus-litigation method can eventually get the job done, but whether water users might rationally choose instead to invest in some modest monitoring effort and adopt pumping regulations that appear to them likely to maintain water levels that will sustain the artesian areas. And ultimately, the question is again how and by whom the choice between these approaches shall be made.

Where the number of users of an aquifer is small enough, the private-property-plus-litigation approach would be expected to be more efficient than investing in rule making plus some form of collective or cooperative monitoring and enforcement. Even where the number of producers is small, however, as with the Indian and Mormon settlements, common-property arrangements have sometimes been preferred when family or religious bonds have lowered the costs of negotiating and adhering to collective decisions.

In much of the world, though, water resources generally and aquifers in particular supply

dozens and hundreds of producers. In those situations, the transaction costs facing each producer of, first, identifying the other producer or producers whose behavior has interfered with the quantity or quality of water he or she can capture, and second, successfully asserting his or her rights against that fellow user or users may outweigh the costs of treating the water levels and water storage within the aquifer as common property and investing in some rules and monitoring and enforcement. It is, I think, reasonable to propose further that as the number of producers from a particular aquifer or within a particular watershed increases, the costs to each of identifying a producer whose behavior has invaded one's right and of enforcing one's right against that producer go up at least in an arithmetic progression and probably by a greater degree.

Which brings me to a fairly common combination (at least in the American West) of common-property and market arrangements in water resource management. Within a watershed, two or more aquifers are often arrayed sequentially beneath the drainage area of an overlying stream, separated by underground constrictions (uplift reaches of faults, bedrock formations, etc.). In these situations, water escaping from one aquifer comprises what is called the base inflow to the next. The actions of producers in the upper aquifer therefore have consequences not only for each other but for the producers in the lower aquifer or aquifers, as lowered water levels in the upper aquifer may actually "choke off' the replenishment supply to the lower ones. Yet consider the economic calculus of any lower-aquifer producer contemplating action against the upper producers. If successful (at considerable cost) in getting the upper producers to restore the flow, that lower producer will have conferred a benefit upon all of his or her neighbors. The logic of collective action tells us what to predict in such circumstances.

How is this quite common situation commonly addressed? In the western U.S. watersheds I am familiar with where this problem has been addressed, it has occurred through the organization of the lower producers into some form of protective association through which they took action against the upper producers, who usually formed a protective

association of their own for their collective defense. The result of these encounters—which are, we must say, themselves costly and time-consuming—is usually some form of guarantee from the upper area to the lower area of a quantity of base inflow. That base inflow is treated by the lower area producers as their common property—assured to them all and, if threatened, defended on behalf of them all. That common-property arrangement quite frequently coexists with market-like arrangements *within* the upper and lower aquifers, respectively. In other words, one might find that upper producers have quantified or quantifiable pumping shares that they can use or transfer among themselves, and the lower area producers similarly may have quantified or quantifiable pumping shares to use or transfer among themselves, but the upper producers have a collective obligation and the lower producers a collective entitlement to that base flow from the upper to the lower aquifer. This mix of institutional arrangements seems to me explainable with the concepts of transaction costs and collective action in ways that provide a logical rational-choice analysis.

In conclusion, common-property arrangements persist in water resource management not *because* water users are obstinate, irrational, or rapacious (though they may in fact be any, and occasionally even all, of those), but because those arrangements play a valued role. They can reduce transaction costs while maintaining responsiveness to time-and-place specificity needs, achieve collective benefits while maintaining a degree of user-based control over decision making, and thus combine and complement the advantages of both regulatory and market approaches.

Thank you for your kind attention, and thank you again for the opportunity to be with you for this conference.

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